INFLATOR

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application Number 60/201,130 filed on May 1, 2000.

BACKGROUND OF THE INVENTION

The present invention relates to gas generators used to inflate air bags in an automobile occupant protection system and, more particularly, to a head curtain inflator designed to protect the occupants of a vehicle during a rollover accident. The novel design provides a steady and uniform production of gas thereby providing sustained inflation of the airbag across its length, and is particularly useful as a linear head side airbag inflator.

Inflation systems for deploying an air bag in a motor vehicle generally employ a gas generator in fluid communication with an uninflated air bag. The gas generator is typically triggered by a firing circuit when the sensed vehicle acceleration exceeds a predetermined threshold value, as through the use of an acceleration-responsive inertial switch.

Air bag inflation systems designed for rollover accidents often utilize a gas generator stored within the B-pillar of the car, for example. Hybrid gas generators are typical and contain pressurized gas that is released upon receipt of a predetermined signal. The gas must then be transferred to the point of application and thus requires additional plumbing.

Certain known side-impact inflators require plumbing to convey gas generated in a relatively remote gas generator to the airbag, thus complicating the manufacturing of the vehicle occupant protection system and furthermore resulting in a relative delay prior to airbag inflation.

Other known gas generators sometimes result in less than optimum inflation profiles. For example, original equipment manufacturers

oftentimes require sustained inflation of the airbag thereby ensuring continued protection during a rollover accident. To ensure sustained inflation, gas generant compositions must exhibit sustained combustion over the desired or required time.

Gas quantities plumbed to the airbag are often not uniform across the inflation profile of the airbag. Stated another way, a portion of the airbag may inflate or pressurize to a greater degree than another portion of the airbag. As a result, the airbag may provide less protection in the regions not completely inflated.

As such, a challenge remains to provide sustained and uniform inflation across the length of airbag employed for vehicular side-impact protection.

Related vehicle occupant protection systems are known. U.S. Patent Nos. 5,322,322, 5,094,475, 3,733,088, 5,540,459, 5,588,672, and 5,921,576 are cited by way of example and are herein incorporated by reference.

SUMMARY OF THE INVENTION

The above-referenced concerns are resolved by a vehicle occupant protection system of the present invention. In accordance with the present invention, a side-impact head curtain inflator contains an elongated housing. Gas exit apertures are spaced along the length of the housing thereby facilitating the release of gas. A propellant body is contained within the housing and is substantially coextensive therewith. An ignition body or rapid deflagration cord is juxtaposed or contained within the propellant body and is substantially coextensive and in physical contact therewith. An airbag or side-impact head curtain airbag extends along the length of the housing and is in fluid communication therewith.

In a preferred embodiment, the propellant body contains a mixture of silicone as a fuel and an oxidizer. The pliant nature of silicone promotes the extrusion of a long cylindrical body coextensive with the

housing. The ignition body may be contained within the cylindrical body of the propellant, axially disposed for example.

Silicone employed as a fuel results in a sustained burn and therefore sustained combustion. The ignition body or rapid deflagration cord provides an essentially simultaneous ignition and burn across the length of the propellant. As a result, gas exiting the gas exit orifices spaced along the length of the housing uniformly inflates an airbag sealed about the length of the housing and in fluid communication therewith. In operation, once a crash event occurs, the airbag is immediately deployed exhibiting a sustained and uniform inflation profile across the length of the housing.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates a first embodiment of the present invention taken in partial section and partial elevation.

Fig. 2 illustrates a second embodiment of the present invention taken in section.

Fig. 3 illustrates a cross-section of the first embodiment taken along the line 3-3 of Fig. 1.

Fig. 4 illustrates a cross-section of the second embodiment of Fig. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In accordance with the present invention a gas generator 10 comprises an elongated housing 12, made from a rigid material such as carbon steel. A plurality of gas exit orifices 14 is spaced along the length of the housing 12. The housing 12 is preferably formed from a carbon steel pipe or tube. The dimensions are based on design specifications. A propellant charge 16 may be disposed within an optional and substantially coextensive perforated tube 18 within the housing 12. A standard igniter 20 or initiator assembly is disposed at one end of the housing 12 and communicates with a signal from a firing circuit thereby initiating operation of the inflator 10. A

plurality of filter screens 22 is fixed to the external surface of the housing 12 whereby a filter screen 22 covers each gas outlet 14. See figures 1 and 3. The welded wire mesh filters 22 are readily obtainable from suppliers such as Wayne Wire, Inc. of Kalkaska, Michigan.

Alternately, a woven wire sock 24, also made by Wayne Wire, Inc., may be used to cover the perforated tube 18 containing the propellant charge 16 and thereby provide suitable filtration of the combustion products. Or, the annular filter sock 24, substantially coextensive with the propellant charge 16, may simply encase the propellant across its respective length if a perforated tube 18 is not provided. Once covered with the woven wire sock 24, the perforated tube 18 is then inserted into the housing 12. The need to weld wire mesh filters 22 on the external surface 32 of the housing 12 is thus eliminated. See figures 1 and 3.

The propellant charge 16 should essentially extend for all or most of the length of the housing 12 thereby facilitating a substantially uniform gas generation once the propellant 16 is ignited. Uniform gas generation across the length of the inflator 10 is desirable so that an airbag 26, fixed and sealed over the length of the housing 12, is uniformly inflated. An insulating material 28 such as woven glass fiber (made by BGF Industries, Inc. of Greensboro, North Carolina for example) or other materials known by their tradenames such as NOMEX (made by Dupont) or KYNOL (made by Nippon Kynol of Japan) is disposed about the periphery of the housing and functions to inhibit heat transfer from the housing to the airbag. The plurality of gas outlets 14 fluidly communicate with the airbag 26 once the propellant 16 is ignited and thereby provide sustained and uniform inflation over the length of the airbag 26.

The propellant charge 16 is formed into a single cylindrical or elongated extrusion that is at least substantially if not essentially coextensive with the housing 12 and the perforated tube 18. The housing 12 also contains an ignition compound 30 in the form of a string or wick coextensively communicating with the propellant charge 16. Stated another way, the propellant charge 16 and the wick 30 are at least substantially, if not

completely, in physical contact for their respective lengths. The wick 30 is an ignitable material such as, but not limited to, cesium potassium nitrate. The wick 30, for example, is readily obtainable from McCormick Selph, Inc. of Hollister, California and is thus marketed as a tin or metal sheath pyrotechnic cord known as RDC (Rapid Deflagrating Cord). The wick 30 is connected to the igniter 20 and is quickly ignited across its length upon actuation of the inflator firing circuit. In general, the wick 30 preferably burns about or at least ten times as fast as the propellant charge 16. Stated another way, the wick 30 must burn at a relatively greater rate, or at least twice as fast as compared to the burn rate of the propellant 16. Ignition of the wick 30 thereby facilitates uniform combustion of the propellant charge 16 and uniform generation of gas across the length of the propellant 16.

In a preferred embodiment, an elongated housing 12 contains a propellant chamber 13 (formed from and within a perforated tube 18) centrally disposed of the housing 12. A plurality of gas exit orifices 14 are spaced along the length of the housing 12 thereby providing fluid communication with an airbag 26. The airbag 26 is sealed about the housing 12 for all or most of its length. A propellant 16 is disposed within the chamber 13. An ignition body or wick 30 is axially disposed within the propellant 16 or at least in physical contact with the propellant 16 for at least the substantial length thereof. An elongated filter sock 24 is disposed radially outwardly of the perforated tube 18 and radially inwardly of an inner wall of the housing 12. An igniter 20 is provided at one end of the housing 12 and communicates with a crash sensor to facilitate ignition of the wick 30. The respective lengths of the housing 12, the propellant 16, the perforated tube 18, the filter sock 24, and the wick 30 are at least substantially coextensive in length, and may be exact in length.

The propellant 16 generally comprises a mixture of silicone as a fuel at about 10-25% by weight, and an oxidizer such as ammonium or potassium perchlorate at about 75-90% by weight. Silicone not only functions as a fuel but also functions as a binder thereby facilitating the formation of pliant cylindrical propellant extrusions.

The propellant 16 preferably comprises silicone as a fuel at about 10-25% by weight; a perchlorate oxidizer such as ammonium, lithium, or potassium perchlorate; and a strontium salt such as strontium nitrate or strontium carbonate as a coolant, wherein the oxidizer and coolant comprise about 75-90% by weight of the propellant. The silicone may be purchased, for example, from General Electric or other well-known suppliers. The other gas generant constituents may be provided by suppliers or by manufacturing methods well known in the art.

The propellant composition more preferably comprises, in percents by weight, 10-25% silicone, 75-90% oxidizer, 1-30% coolant, and 1-20% of a slag-forming constituent. The oxidizer may for example be selected from inorganic perchlorates and nitrates such as sodium perchlorate, potassium perchlorate, ammonium perchlorate, potassium nitrate, ammonium nitrate, and phase stabilized ammonium nitrate. The coolant may for example be selected from metal hydroxides such as aluminum hydroxide; metal carbonates such as calcium carbonate, magnesium carbonate, strontium carbonate, and sodium carbonate; and inorganic oxalates such as calcium oxalate, strontium oxalate, and ammonium oxalate. The slag-forming constituent may for example be selected from metal oxides such as aluminum oxide and iron oxide. It has been found that gas generating compositions containing silicone and a perchlorate oxidizer burn at relatively lower temperatures when a coolant, in accordance with the present invention, is added to the mixture. As a result, cooling requirements of gas generated within the inflator 10 can be substantially minimized.

When used within a vehicle, the inflator 10 is preferably mounted within the headliner on either side of the vehicle wherein the length of the inflator 10 runs substantially parallel with the length of the vehicle. Each side of the vehicle would thus contain an inflator 10 as described above. When actuated by remote fire circuitry, the airbag 26 is forced down from the headliner thereby covering the side windows and providing a cushion during a rollover or other type of accident. The present invention exceeds customer

requirements of at least five seconds of sustained inflation of an airbag 26 in fluid communication with the gas generator10.

It will be understood that the foregoing description of the preferred embodiment of the present invention is for illustrative purposes only, and that the various structural and operational features herein disclosed are susceptible to a number of modifications, none of which departs from the spirit and scope of the present invention as defined in the appended claims.